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The Apicultural Potential through Improved Beekeeping Technology and Education in Kenya

Introduction

The Republic of Kenya's traditional reliance on subsistent farming is not putting enough food on the table to feed its 48 million citizens and they are looking towards commercializing the agricultural industry. However, Kenya's arid and semi-arid areas make up more than 80 percent of the country's landmass, making large scale farming difficult. Yet this terrain does not pose as a problem for the insect known for its pollination of many agricultural crops and its sweet product. One solution to food insecurity and unemployment is found in the many advantages beekeeping provides Kenyans.

In fact, beekeepers can see huge returns, as apiary production only requires a small piece of land for which hives are to be placed. Therefore, the practice provides livelihood opportunities for women and landless people (CTA Spore, 2017). Less capital and labor are involved in apiary production compared to a farming operation. Once Kenyans are educated on how to handle bees, it is simple to build beehives and swarm traps, which apiarists can use to attract wild bee swarms into their hives, further limiting their initial costs. A large business opportunity in beekeeping can significantly boost a farmer's income by as much as fifty percent (Page, 2016). Beekeepers have a strong market demand for honey and other hive products such as wax, royal jelly, propolis, and pollen which further strengthen the incentive to start with the apiculture industry (Page, 2016). These hive products can provide an important food source as honey is a non-perishable food item that provides carbohydrates. Pollen is another food source that provides many micronutrients including amino acids, vitamins, minerals, and enzymes that are lacking in most Kenyan's diets (U.S. FDA, n.d.).

There are also many indirect advantages of keeping bees in addition to obtaining common hive products. Bees are good pollinators of plants and play a huge role in bio-diversity and improvement of crop yields (Daily Nation, 2014). This means small farmers who keep a bee hive near their food plot can boost their production level and quality of their produce through its pollination. Research has shown that honey bee pollination enhances production in many crops grown in Kenya including coffee, acacia pods, cashew, strawberry, guava, coconut, pepper and those in the cucurbit family such as watermelons, pumpkins, cucumber, and squash (FOA, 2007). However many farmers are not aware of the benefit that honey bee pollination brings to their crops, so education would increase its adoption by farmers.

Additionally, the presence of bees have shown to protect farmer's food plots from devastation by elephants as the sound of bees is a natural deterrent of common village threat (Elephant and Bees Project, n.d.). With this knowledge, a Kenyan farmer can set up a "bee-trap" around the village garden in which Kenyan top-bar bee hives are suspended from wire ropes above the ground. When an elephant herd comes to destroy the produce plot, the barrier line will be tripped, causing the hives to shake, and disrupting the aggressive Africanized bees to seek their attacker. Once the unknowing elephant gets stung, it will remember and will not be back for food again (Elephant and Bees Project, n.d.). This practice has been supported in research that looked into implementing beehive fences as effective deterrents for crop raiding elephants in Northern Kenya compared to thorn bush barriers. The study presented data from 45 farm invasions recorded over a two-year span. Thirteen groups of elephants approached the beehive fences and turned away. Of the 32 successful farm invasions, only one bull elephant broke through the beehive fences. These results demonstrate that beehive fences are more effective than thorn bush barriers at deterring elephants and may have a role to play in alleviating farmer–elephant conflict (Douglas-

Hamilton, King, & Vollrath, 2011). Additionally, the harvesting of 106 kg of honey during the trial period suggests that beehive fences may also improve crop production and enhance rural livelihoods through honey sales.

Country & Family

Over 80 percent of Kenyans, particularly those living in rural areas, derive their livelihoods from agricultural related activities (Food Security Portal, n.d.). The Republic of Kenya has an agricultural based economy in which smallholder farming accounts for approximately 75 percent of agricultural production and over 60 percent of employment (Feed the Future, 2013). Kenya is a leading producer of tea and coffee, as well as the third-leading exporter of fresh produce, such as cabbages, onions and mangoes. Small farms grow most of the corn and produce potatoes, bananas, beans and peas.

Kenya lies exactly astride the Equator, which bisects the country in an east-west direction. This results to Kenya's climate varying from tropical along the coast to temperate inland to arid in the north and northeast parts of the country. This climate supports a wide variety of plant life, which the nation is known for. Kenya has many different altitude zones, each of which has a characteristic floral climax. In zones where the altitude is 1200-1500m and 1500-1800m, the climax vegetation still consists of indigenous species, where traditional beekeeping is carried out (NAFIS, n.d.). Particularly good honey crops in these zones are obtained from Labiatae and species of Acacia. The unique species of nectar and pollen rich plants has resulted in the country's historical record of beekeeping.

Traditional beekeeping is one of the oldest practices carried out by tribes in Kenya such as the Kamba, Maasai, Samburu, Dorobo, Tugen, and Mbeere (Fraizer & Muli, 2011). Among all of these tribes, beekeeping was strictly a man's business and only boys received training through apprenticeships. Log hives were typically used, though honey hunting was also practiced to a small extent. Honey has played, and continues to play, an important role in nutrition as well as medicine. It is used for treating coughs, healing wounds, and as an ingredient in many herbal remedies. In most tribes, honey is a crucial component of the bride price and cannot be substituted with money. Among the Kamba people, honey is also used to treat hoof and mouth disease in cows. It is also given to women after birth to reduce her infant's colic pains. Knowledge of keeping bees has been passed on from generation to generation, with some family lineages named after their beekeeping practices.

Interestingly, there is a significant difference in indigenous knowledge among beekeepers today. Varieties of factors have contributed to this, but through interviews with beekeepers, they learned the grandfathers of some individuals were traditional beekeepers while their fathers were not (Frazier & Muli, 2011). The acceptance of Christianity had an impact on the loss of beekeepers and beekeeping in some areas. Christian missionaries viewed the customs of brewing beer from honey and using honey to pay a bride price as unacceptable. For this reason, some Kenyans who accepted Christianity gave up beekeeping. Regardless of the reasons, organizations like the International Center for Insect Physiology and Ecology can play an important role by helping beekeepers across East Africa bridge this gap in indigenous knowledge, while also improving their management techniques through an increased understanding of honey bee biology.

In Kenyan culture, the family is a very important aspect of life. Three-quarters of Kenyan families still live in rural areas where the traditional lifestyles in the countryside revolve around subsistence farming and trips to local markets and shopping centers (Our Africa, n.d.). Today it is common for the typical Kenyan family to have several generations living under the same roof. Within this extended family unit, aunts, uncles and cousins are equally as close to their siblings and parents. Also in this family, the husband could have several wives, although this practice is diminishing due to Christian influences. The man normally sets his house and each of his wives set their house near their husband's house. Each of the children will live with their respective mother until they are old enough to take care of themselves. In the

family situation, the father is typically the breadwinner of the family and the mother often works and maintains the household. Since the Kenyan family is so intertwined among generations, beekeeping is a practice that could be passed down as a way to supplement the household income and diet.

Challenges & Solutions

Intense droughts that have plagued the region, high cost of fertilizer, and ineffective management of devastating pests have significantly decreased crop production and have resulted in high food prices in the past several years (Food Security Portal, n.d.). High levels of malnutrition afflict the country's poorest people. In the arid and semi-arid areas, around 337,000 children who are under the age of five are suffering from acute malnutrition, and undernutrition is a leading cause of death among children under five (World Food Programme, n.d.). Currently 60 percent of Kenyans live below the poverty line due to small farmers' inability to produce enough food for their families (Mohajan, 2014). This translated means that over half of the population is living under the poverty line on less than the average income of \$1.25 per day (Mohajan, 2014). Thus, 3.4 million people face severe food insecurity (Reliefweb, 2018).

The Government of Kenya continues to view agriculture as a high priority tool in promoting their national development (Food Security Portal, n.d.). In order to reduce the poverty and food insecurity level that Kenya faces, Vision 2030 goals includes agriculture goals that will help to increase food production beyond that of subsistence farming (FAPDA, 2012). One sector of the agriculture industry that has been identified for improvement is the beekeeping. The government of Kenya has long looked to increase its level of honey production as only 20% of its estimated potential has been exploited (NAFIS, n.d.).

Several challenges stand in the way of unlocking Kenya's apiculture production potential. The two biggest being improper hive and harvesting technology along with the lack of education for the beekeeper. There has been extensive focus on shifting hive design to modern technology such as the Kenyan Top Bar or Langstroth hives that would allow the Kenyan beekeeper to better manage and extract honey more efficiently (NAFIS, n.d.). The Kenya Top Bar Hive (KTBH) resembles a wedge box with wooden bars of specific measurements at the wide top part and a roof above the bars. Bee management is possible with this hive, making it easier to harvest and manipulate colonies for more honey production compared to traditional log hives. However, combs in the top bar hive are not supported and can break if not handled carefully. Since wax is harvested with honey, the bees are forced to build more wax to replace harvested combs, which results in lower honey yields albeit with more harvested wax. In addition, the volume, like in the traditional log hive, is fixed so the hive can fill and get congested very quickly in the honey flow season. An overcrowded hive can divide and swarm, leading to reduced honey production.

Another proposed hive is the widely used European Langstroth Hive. This design consist of a box shaped with several compartments and frames that make the combs very strong. A mesh queen excluder is placed above the lowermost compartment known as the brood chamber, allowing only the worker bees to move through it. Since entry to the hive is located at the base of the brood chamber, the queen cannot lay eggs in the compartments above the brood chamber, thus combs in these chambers will contain honey only. The honey is extracted by means of centrifugal honey extractor, returning the combs relatively intact. Empty combs are returned to the hive for the bees to refill with new honey, thus saving the insects from wasting time and energy to construct a replacement comb. Honey harvests are maximized, as the beekeeper can obtain several honey crops within the year. Combined with the fact that honey is separated completely from the brood, this extraction method ensures high quality honey. By adding more supers, additional space can be created in the hive, which is important during honey flow period. The disadvantage of frame hives is the fact it is more expensive (between Sh3,500 and Sh8,000) and require a greater level of investment as well as more beekeeping skills (Nyaga, 2016).

Despite fifty years of government efforts to improve beekeeping technology, the region still showed low rates of modern hive adoption. In an effort to increase innovation diffusion, the Kenyan Agricultural Research Institute developed the Agricultural Technology and Information Response Initiative (ATIRI). ATIRI initiated study to assess the status of Langstroth, Kenyan Top Bar, and log hives among beekeepers, and determined the best hive for arid climate beekeeping. The study observed two groups of beekeepers, and recorded data on “hive occupation, honey production, honey quality, cost of installation and inspection of hives, cost of harvesting, acceptability of the hives by the farmers, and ease of management of the apiaries” (Mulindo, et al., n.d.). The overall findings showed that while the KTBH and Langstroth hives yielded a better quantity and quality of honey than the log hive (12, 10, and 8 kg/harvest respectively), the log hive showed an exceedingly greater occupancy rate of nearly 80% (KTBH showed 40% and Langstroth 30%).

The conclusion of the study was that each hive possessed desirable characteristics for beekeepers. While efficient and clean honey production is often the gold standard for most beekeepers, ATIRI acknowledged the fact that low hive occupancy rates negate the benefits of managed harvesting and production. Thus, the next step in the research process was to develop a hive that integrated the benefits of each hive. The result of this collaborative process was the “Kapkuikui Super Log Hive”. The new, three-way hybrid hive integrates the preferable living conditions of the log hive with a grooved interior to encourage a straight comb-formation, which is more manageable for beekeepers. The hive is still a fixed-comb design, but allows for more selective comb harvesting, thus improving the quality and quantity of honey, and also preserving bee brood. The new hive was tested under the same conditions of the original study and yielded 18 kg/harvest with the 75% occupancy rate, proving to be the superior hive design. The Kenyan Agriculture Research Institute advertises the hive in their beekeeping guide as one that “combines modern and traditional technology” (Cheng’ole, Duyu, Musila, & Chesang, 2008).

I believe an important part in the method of solutions is to keep many indigenous beekeeping practices at the heart of tackling apiculture challenges. For example, North Western Bee Products (NWBP), a UK-based company and importer of Zambian honey build its successful business model from a development project founded with respect for indigenous practices. Funded by the Zambian government, the initial project sought the increase rural incomes via beekeeping (Frazier & Muli, 2011). The first decision of the project leader, David Wainwright was to determine what type of technology should be utilized. Wainwright immediately recognized the trend of using modern hives for development work. Yet he questioned the likelihood that a hive that promise potential for greater production would be successful for small-scale Zambian beekeepers. This lead Wainwright to realize the benefits that the Zambian bark or log offered: easy construction, made from local materials, and flexibility they offered beekeepers to engage in other activities. The project focus was to create new market opportunities for honey producers, but before they could tackle market demands, the quality of honey needed to be improved. As is common in most of East Africa, the harvested honey is often used to brew local beer. The honey preferred for this ferment beverage contains the bee brood, pollen, and even dead bees. However, this quality of honey would be unacceptable for market sale. Instead of changing their husbandry, the project focused on teaching selective harvesting methods that would ensure clean honey. In addition, the previous methods of processing honey were inefficient and slow, thus the project encouraged beekeepers to take their own initiative in designing and constructing new presses and draining systems.

The result of these initiatives was a honey product that NWBP was proud to purchase and sell. Further initiatives were taken to strengthen local beekeeping networks and market opportunities. However, for the purposes of understanding the integration of indigenous knowledge the details of these aspects are not necessary. This case study serves as an excellent example of a western organization approaching development from an indigenous-inclusive perspective. This project, while still focused on improving the economic situation of rural farmers, was able to avoid altering traditional husbandry practices. The

continued use of log hives allowed farmers to remain autonomous and retain a sense of cultural ownership of their product, which contributed to the long-term success of NWBP. Ultimately, the honey producers expand into international markets, all while maintaining their traditional beekeeping practices.

The government must exploit the opportunity to place effective and efficient systems for production, processing, and marketing of honey in partnership with rural beekeepers communities to meet the growing demand in urban and international markets (African Beekeepers Limited, n.d.). By taking advantage of a blend of modern and traditional beekeeping technology, such as Kapkuikui Super Log Hive, that allows the producer to extract honey at a higher level, Kenyan beekeepers will have a significantly higher product on the market. A way to promote cleaner and higher quality honey is pushing the Kenyan Government to establish honey marketing labeling so that real honey can carry its seal in the market place. Another way to increase honey production and build a reputable honey source is through local cooperatives. Creating beekeeping and honey processing co-ops in which beekeepers from across the area receive training, assistance, and access to clean honey production facilities would greatly boost the industry (African Beekeepers Limited, n.d.). By local beekeepers pooling their knowledge and resources together, a dependable supply of honey that highlights Kenya's unique floral sources can sold across the world.

For Kenyans to reap the direct and indirect benefits beekeeping offers, interested individuals must be educated and trained on making hives, attracting bees, harvesting, and refining honey to make the apiary production economically sustainable in Kenya (Nyaga, 2016). The Kenyan government has continued to support beekeeping by offering subsidized training at the National Beekeeping Station to equip apiarists with the necessary basic skills to run the enterprise (TPSFP, n.d.). The long-term goal of this training is to surpass the nation's potential in honey production as only twenty percent has been tapped (NAFIS, n.d.). In order to do so, Kenyan beekeepers must be taught proper handling skills and how to work a colony of Africanized honey bees as they are more easily agitated than other subspecies such as the European race found in the United States. However, the Africanized honey bee aggressive behavior does benefit the beekeeper as it means their colony is less inclined to be overtaken by pests such as the devastating Varroa mite.

Conclusion

Some challenges that are currently holding beekeeping from expanding is the lack of adequate and intense research on the existing beekeeping technologies, equipment, and product utilization. Also a low prioritization of beekeeping in relation to other enterprises in the wider agricultural sector has also been a problem facing the apiculture sector as it means less funding from the government. Kenya still stands in a unique place to be a leader of sustainable beekeeping promotion. The government is one of the primary sources of extension and on site education for emerging beekeepers and beekeeping cooperatives. The influence these extension personnel carry is not to be underestimated, or underutilized. As we have seen, the Kenyan government is a staunch supporter of modern hive adoption, despite unimpressive results. In moving forward, the Kenyan government must take heed in their decisions regarding the use of technology that may be unsuitable for beekeepers and the bees themselves.

The practice of beekeeping offers many beneficial ways to improve Kenya's current state of food insecurity. The apiculture industry not only increases crop production through pollination, but also provides hive products, which families can use as food or sell in the marketplace. Beekeeping is a promising livelihood for families to take part in which women and people without land can still operate. By spreading education on how to manage colonies, utilizing both traditional and modern hive designs, and producing high quality honey, the nation's honey production level and presence of reputable hive products in the local and international marketplace will strengthen. Through the government's influence

and support of modern apiary education courses, beekeeping is a great solution to bridge Kenya to high employment and food security.

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